Status of VEP analyses

Simona Rolli
Tufts University

VEP analyses

VEP group is a subgroup of the Exotic Physics Group
S.R. And Eiko Yu are the current conveners

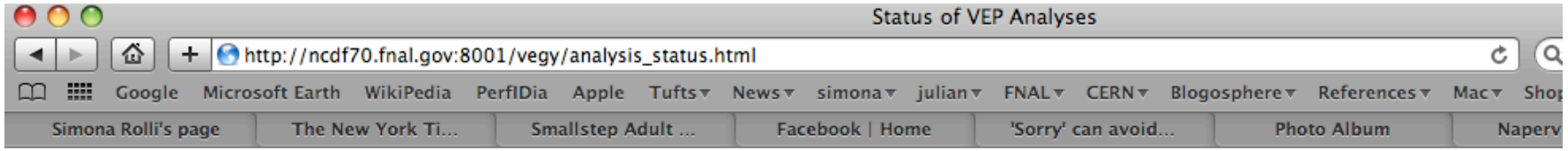
VEP is a working group:

prepare analyses to proceed to Exotic forum for blessing. The details needs to be solved in the VEP group;

VEP is a small group, a few analyses ongoing

Restructured meeting schedule: every other week on Tuesday, mandatory short status report from everybody;
Larger status reports less frequently.
Planning to complete and bless by end 2010

VEP Analyses



Status of VEP Analyses

Analyses presenting at VEP

Topic	Authors	Last VEP presentation
Z' in the muon channel	Edward Quinlan, Daniel Whiteson	October 6th 2009
Search for W' to e-nu	YuChul Yang, Jieun Kim, DongHee Kim	11 August 2009
Searches in Multijets	Tim Lou, Eva Halkiadakis, Amit Lath, Daryl Hare, Rouven Essig, Scott Thomas	September 9th 2009
Fermiophobic Higgs in the 4-gamma channel	Atsunari Hamaguchi, Toru okusawa, Yoshihiro Seiya, Kazuhiro Yamamoto	14 July 2009
Search for Anomalous Production of photon + jets	Sam Hewamanage, Jay Dittman, Nils Krumnack, Ray Culbertson, Sasha Pronko	16 June 2009
Search for 1st and 2nd generation leptoquarks	Simona Rolli	October 6th 2009

Search for Z' into μμ

Previous searches for Z' used a template method to fit the mass spectrum in the hypothesis of an extra gauge boson.

Daniel Whiteson & Eddie Quinlan (UC Irvine)
Kyle Cranmer (NYU)

This analysis uses a matrix element method.

A per-event probability is calculated by convoluting LO matrix elements with functions describing the detector resolution (transfer functions)

$$P(\vec{x}|M) = \int P(\vec{x}|\vec{y})P(\vec{y}|M)\ \mathrm{d}\vec{y}$$

Transfer function $$T(\Omega; A_i, \mu_i, \sigma_i) = \sum_{i=1}^{3} A_i \exp\left(-\frac{(\Omega-\mu_i)^2}{2\sigma_i^2}\right)$$

Simulated muons are use to calculate Ω

where $$\Omega(\vec{x}_{true}, \vec{x}_{meas}) = \frac{(p_T^{true})^{-1} - (p_T^{meas})^{-1}}{\delta_p}$$

As opposed to template method the ME method uses the information on the detector resolution event by event (some events are better measured than other)

Z' into μμ

Likelihood Ratio

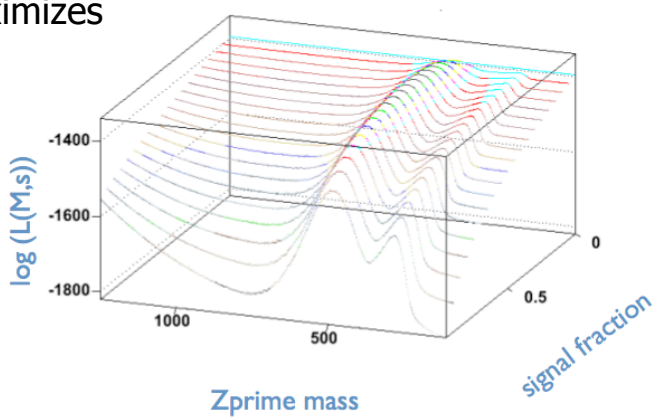
From the per-event probabilities, we calculate the likelihood ratio for a large set of events $\vec{X} = (\vec{x}_1, \vec{x}_2, \ldots, \vec{x}_n)$

$$L(\vec{X}, M_{Z'}) = \prod_i^n \frac{P_{Z+Z'}(\vec{x}_i, M_{Z'})}{P_Z(\vec{x}_i)} \qquad (5)$$

- Since $M_{Z'}$ is unknown, the Z' per-event probability (and therefore the likelihood ratio) is a function of $M_{Z'}$
- Simulated experiments tell us what sort of conclusions we can draw from the likelihood ratio (i.e. existence of the Z' and value of $M_{Z'}$)

• For a set of events find the Z' mass and signal fraction that maximizes the joint likelihood

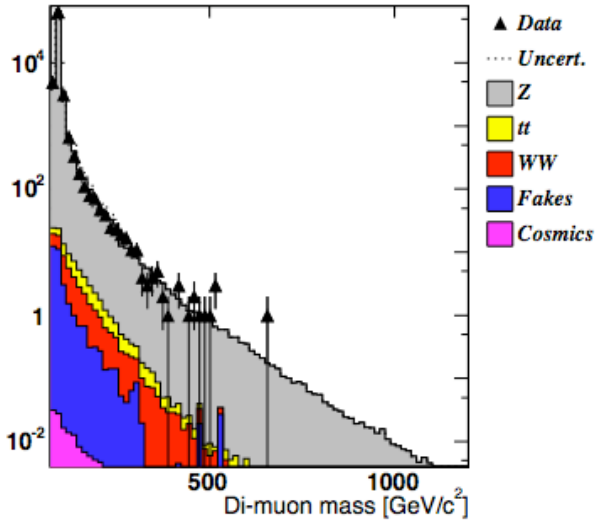
Pseudo-experiment with 92 bg events, 500 GeV Z' with signal fraction of 0.3



Z' into μμ

Event Selection is the same as the previous search:

≥ 2 opposite-sign tight muons
≥ 1 CMUP or CMX muon and corresponding trigger
$m_{\mu\mu} > 70$ GeV
No identified cosmic rays (COT-based)
$\lvert\Delta t_0(\mu,\mu)\rvert < 4$ ns
$\lvert\Delta z_0(\mu,\mu)\rvert < 4$ cm



Background sources

- Z/γ^*
- $t\bar{t}$
- WW
- Cosmics
- Fakes

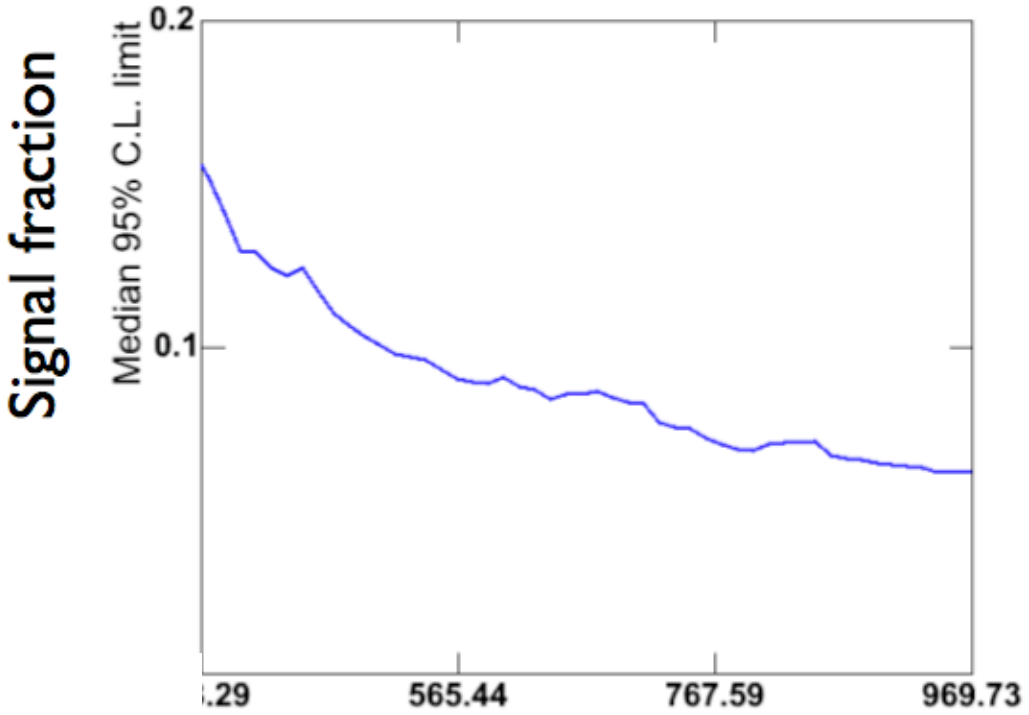
Source	Events ($M_{\mu\mu} > 70$)	Events ($M_{\mu\mu} > 250$)
Z	73983.2	89.6
WW	36.1	1.3
$t\bar{t}$	31.8	1.1
Fakes	32.0	0.3
Cosmics	0.2	0.02
Total	74083.2	92.2
Data	73732	92

2.3fb-1

Z' into μμ

Sensitivity
Background-only
pseudo-exps

0.1 =~ 9.2 events



To Do:

- Systematics
  - Not expected to make large differences
  - Adding to simulated experiments:
    - PDFs, k-factor for Z, momentum scale, acceptance at high pT
- Ready for full status in few weeks

Search for W' into νe

In various extension of the SM extra gauge bosons are predicted

Yuchul Yang, Jieun Kim, DongHee Kim
(Kyungpook National Univerisy)

Event signature similar to $W \rightarrow e\nu$

Look for excess in the "electron neutrino" transverse mass distribution over standard model expectation.

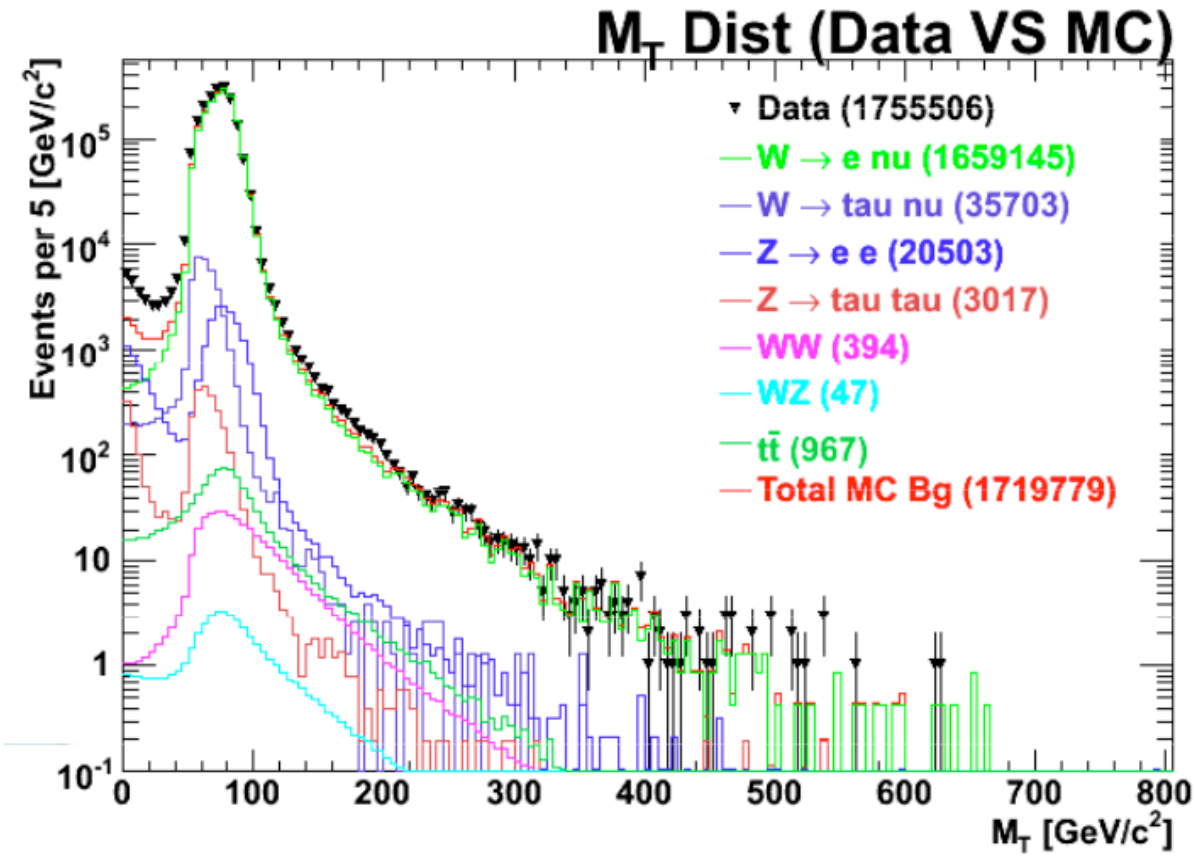
Background:

- $W \rightarrow e\nu$
- $W \rightarrow \tau\nu \rightarrow e\nu\nu\nu$
- $Z \rightarrow ee$
- $Z \rightarrow \tau\tau$
- $Diboson \quad (WW, WZ)$
- $t\bar{t}$
- $QCD \rightarrow misID \quad with \quad e, \; met$

			EWK MC X-Section		Thoery Value	
Pythia	**# Gen.**	**Acc. * Effi.**	**X-Sec. (pb) * K-factor**	**Expected # of Events**	**X-section(pb)**	**Expected # of Events**
W ->e nu	19 M	2.05 X 10^{-1}	2744.0	1,659,145	2687.0 (NNLO)	1,624,680
W -> tau nu	6 M	4.52 X 10^{-3}	2744.0	35,703	2687.0 (NNLO)	34,916
Z -> e e	14 M	1.43 X 10^{-2}	497.0	20,503	251.3 (NNLO)	10,367
Z -> tau tau	5 M	3.06 X 10^{-3}	498.0	3,017	251.3 (NNLO)	2,267
WW	7 M	1.07 X 10^{-1}	1.25	394	13.25 (NLO)	4,184
WZ	8 M	4.39 X 10^{-2}	0.365	47	3.96 (NLO)	511
ttbar	5 M	4.90 X 10^{-2}	6.7	967	6.7 (NLO)	967
Total				1,719,779		1,677,942
Data				1,755,506		1,755,506

Up to P17

W' into νe



To Do:

- Update to full dataset
- Check the electron energy scale and resolution
- Estimate QCD background

Search for resonances in multijets

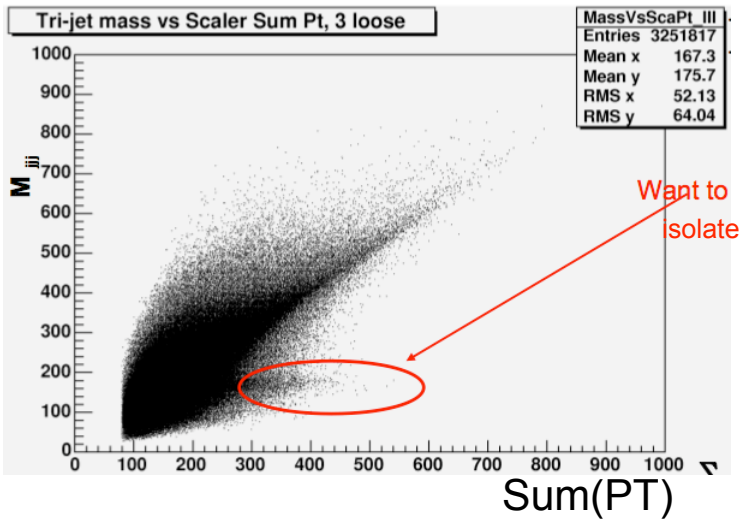
An interesting way to look for new physics in multijet !

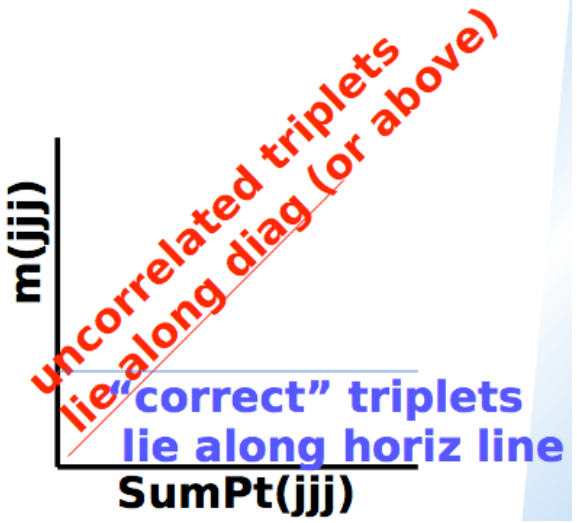
Studying pp → QQ → 3j+3j = 6j

Amit Lath
Eva Halkiadakis, Daryl Hare, Tim Lou, Dean Hidas
(with theorist Scott Thomas)
Rutgers, the State University of NJ

Basic idea: plot M(jjj) vs Sum(P_T(jjj)) for all triplets

A "simple" test: rediscover top!



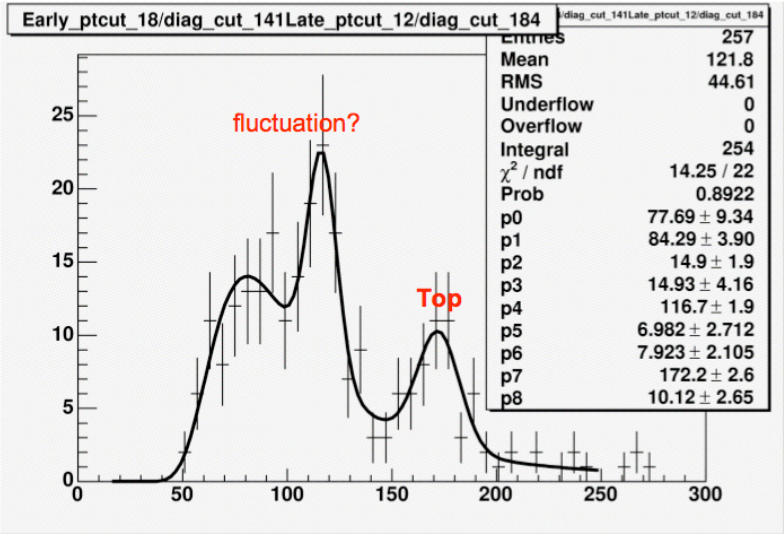


Diagonal Cut

$M_{jjj} < \sum |p_{T,j}| - \text{offset}$

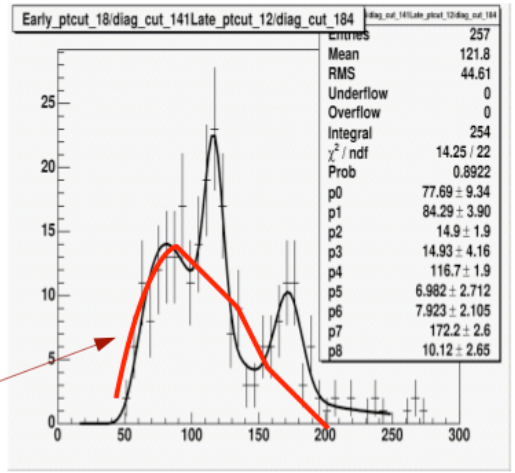
Multijets resonances

What do we see in the data?



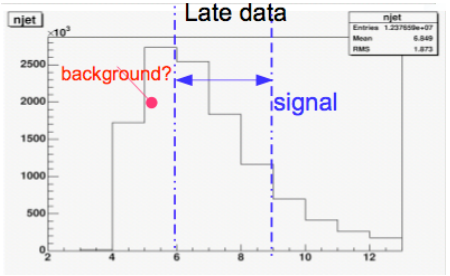
There is a problem with fitting signal+ background

- Our problem is that we have no appropriate background MC.
  - ALPGEN 6-parton takes forever to generate.
- What happens when you fit SIGNAL (gaussians) and BACKGROUND (landaus) at the same time?
  - Horrible things: fluctuation can drive down background.
  - Fitter is happy, but results are misleading.
- Need independent, ***data-driven*** background estimate!



We are using Njet>=6 for signal.

How about Njet==5? for background?



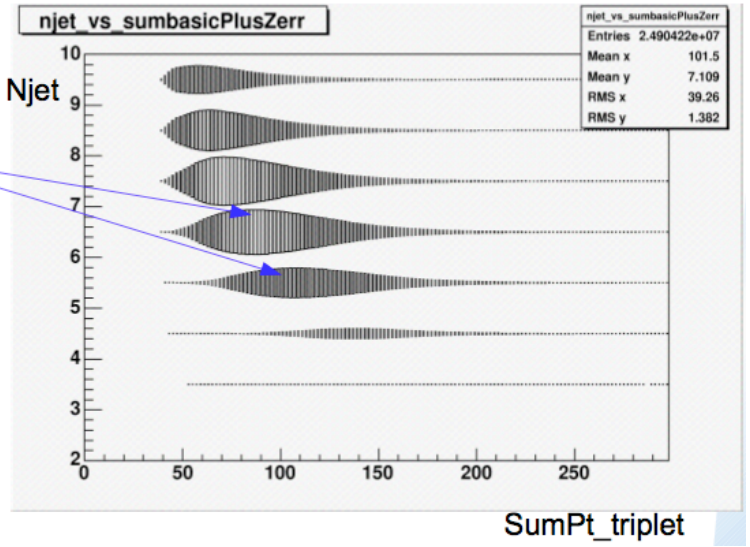
Multijets resonances

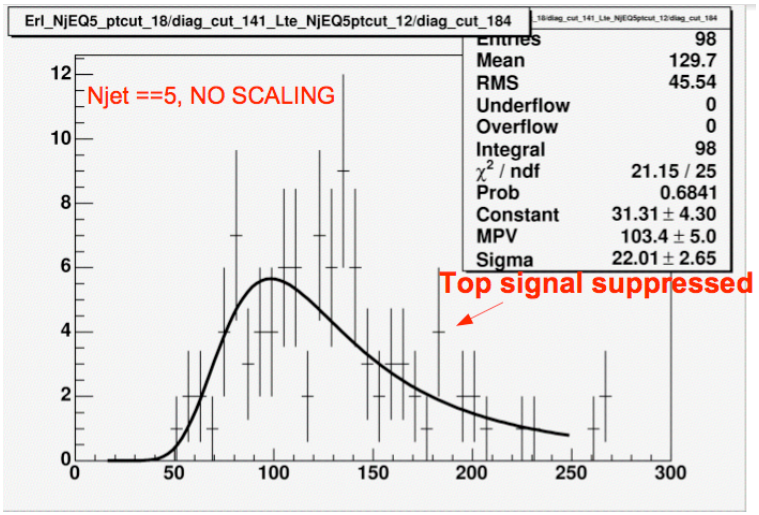
Look at SumPt3 (triplet sumpt) after basic/adv cuts.

Notice that peak shifts lower, for higher njet.

- Same collision energy, distributed among more constituents?

We need to scale the Njet==5 jets to match.





To Do:

Get rid of Early/Late distinction

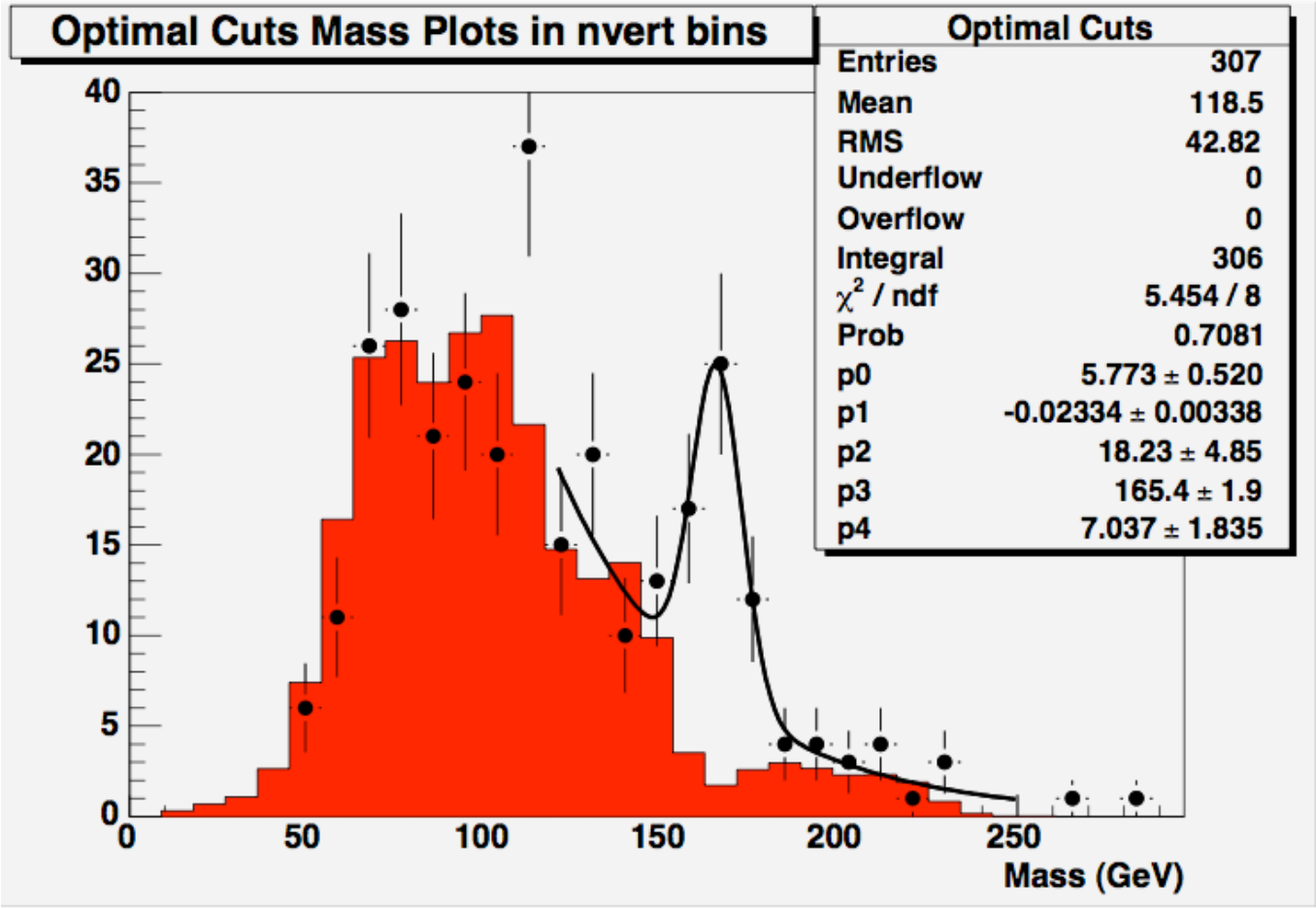
Nvertex is now used to arrange data

Cross check the top contribution to 5 jet bin;

Understand why the top MC acceptance is 10x lower than data

ISR/FSR effects, JES…

Multijets resonances

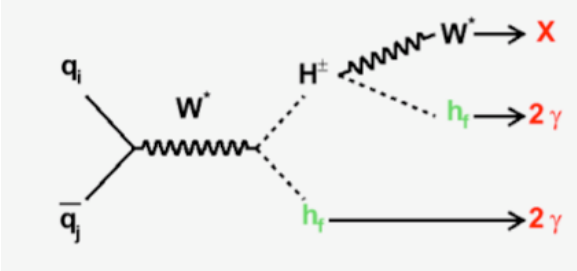


Search for Fermiophobic Higgs into 4 γ

Atsunari Hamaguchi,
Toru Okusawa, Yoshi Seiya,
Kazuhiro Yamamoto
Osaka City University

2DHM-typeI models predict fermiophobic Higgs
The search is conducted in the channel:

$$p\bar{p} \rightarrow H^{\pm}h_f \rightarrow W^{*}h_f h_f \rightarrow 4\gamma + X$$



Selection Criteria
Event-Vertex, Geometrical & Kinematical Cut
Event-Vertex $\lvert Z_{vert}\rvert \leq 60$cm
CEM
$E_T > 15$GeV
Photon ID Cut
no track
$E_{Had}/E_{EM} < 0.055 + 0.00045 \times E$
χ^2(Strips + Wires)/2.0 < 20
Conversion Photon ID Cut
track
$E_{Had}/E_{EM} < 0.055 + 0.00045 \times E$
χ^2(Strips + Wires)/2.0 < 20
Track$-P_T < 1 + 0.05 \times E_T$
Isolation Cut
E_T>20 GeV : iso4 < 2.0+0.02×(E_T-20.0) GeV
E_T<20 GeV : iso4/E_T < 1.0

The signature is quite clean and straightforward
One important issue is still that of photon selection cuts

Several Selection cuts were tried and rejected
An isolation cut was added instead of DeltaR

Fermiophobic Higgs: background

The number of background events is estimated from the number of jets faking photons in 4-γ final state. The number of background events is given by:

$$N_{BG}(E_T^{\gamma}) = \int P_{jet\to\gamma}(E_T^{jet}) \times dN/dE_T^{jet} \times z(E_T^{jet}, E_T^{\gamma})\, dE_T^{jet}$$

$$= \int P_{jet\to\gamma}(E_T^{jet}) \times \frac{dN/dE_T^{jet}}{dN_{jet}/dE_T^{jet}}\, dN_{jet}/dE_T^{jet} \times z(E_T^{jet}, E_T^{\gamma})\, dE_T^{jet}$$

1) 2) 3)

1) $P_{jet\to\gamma}(E_T^{jet})$ is the E_T^{jet} dependent probability of a jet faking a photon in the diphoton sample. We measure this fake rate ($P_{jet\to\gamma}$)in the jet samples.

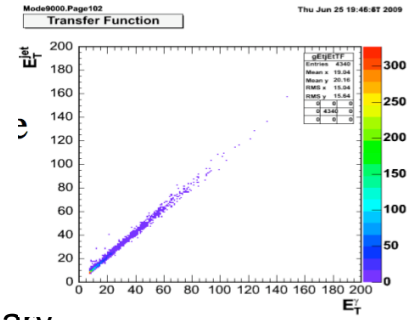
2) dN/dE_T^{jet} is the E_T^{jet} distribution in diphoton sample. dN_{jet}/dE_T^{jet} is the E_T^{jet} distribution in the jet triggered samples. We compare dN/dE_T^{jet} with dN_{jet}/dE_T^{jet} .

The term $\frac{dN/dE_T^{jet}}{dN_{jet}/dE_T^{jet}}$ cancels if the E_T^{jet} distributions are the same in the sample used to measure the fake rate.

3) $z(E_T^{jet}, E_T^{\gamma})$ is a matrix which gives the probability of a jet of E_T^{jet} to be measured as E_T^{γ}.

- We will fit to Z distributions in each E_t^{jet} (E_t^{γ})

  ($Z = E_t^{\gamma}/E_t^{jet}$)



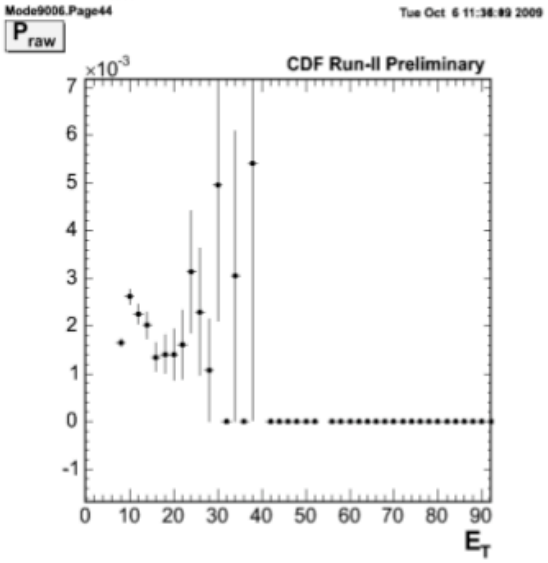
Fermiophobic Higgs:status

1)Fake probability:

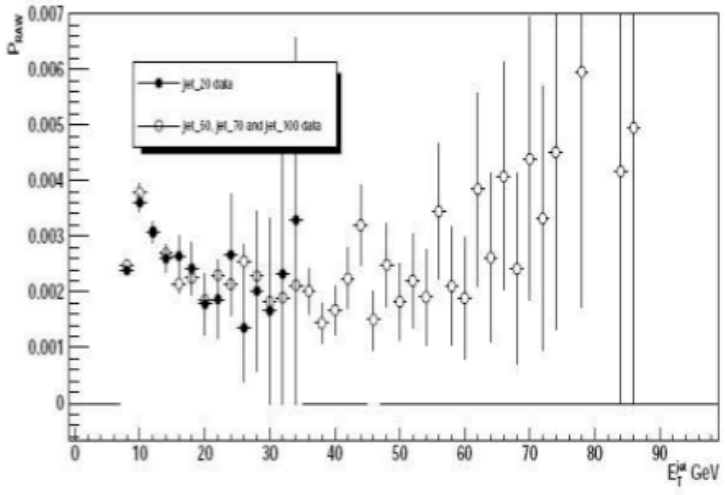
$$P_{raw}(E^{jet}_T) = \frac{N_{\gamma-candidate}}{N_{jet}}$$

- N_{jet} : Number of jet , $N_{\gamma\text{-candidate}}$: Number of "γ"
- Jet requirement
  - Jet $E_T > 15GeV$
  - Jet $|\eta| < 1.1$
  - Use the $3,4,5^{th}$ ··· highest E_T Jet in an event

- P_{raw} (JET_20)



- CDF Note 6838



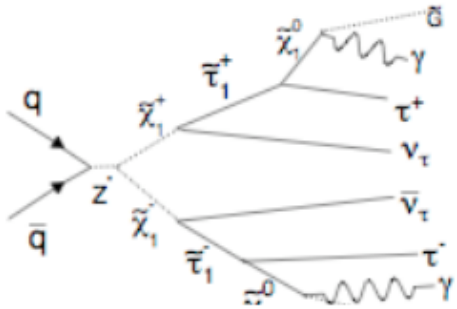
Still discrepancies with previous studies: more checks in progress

Search for anomalous events in γ +Jet

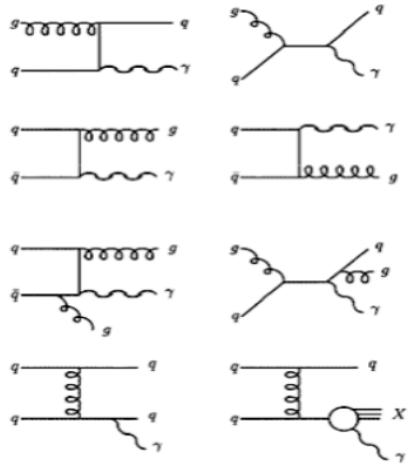
Sam Hewamanage, Jay Dittmann, Nils Krumnack
Baylor University

Ray Culbertson, Sasha Pronko
Fermilab

Various processes can give rise to anomalous production of γ+Jet



Various SM processes also contribute!



Scan kinematic plots photon E_T, invariant mass of photon and jet/s, missing transverse energy etc. for an excess.

Event Selection

- Require at least one of the three triggers
  - PHOTON_25ISO, 50 and 70
- Must be in good run list (v19_pho)
- >=1 Class 12 vertices
- z < 60 cm
- Photon + >=1 Jet

Jet Selection

- Cone size =0.4, JetClu
- Remove only the photon from jet list
- Corrected up to level 6 (UE), particle jet
- Require one or more jets with Et >15 GeV
- Can be in Central or plug (EvtEta<3.0)

This analysis was previously blessed with 2 fb-1 of data
Updating now with full statstics

Anomalous γ+jet

Final Selection

1. A photon passing tight photon ID cuts, Et>30GeV
2. Photon must be in-time (> -4.8ns & <4.8ns)
3. Reject photons with phoenix track
4. Reject if beam halo
5. 1 or more Jets

Summary of Background

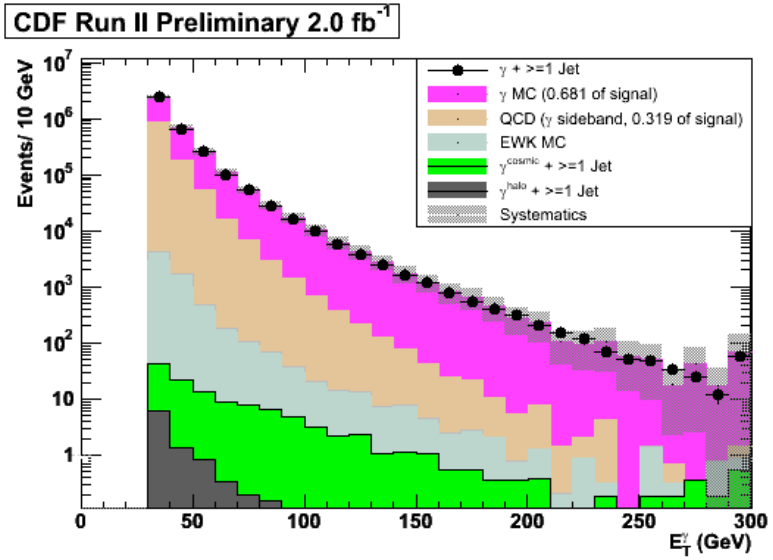
	Photon + ≥1 Jet	Photon + ≥2 Jets
SM Photon	2.6M	650k
QCD	1M	280k
EWK	5362	1321
Cosmic	110+/-9	7+/-2
Beam Halo	9	<1
PMT Spikes	0	0

August 8 2009

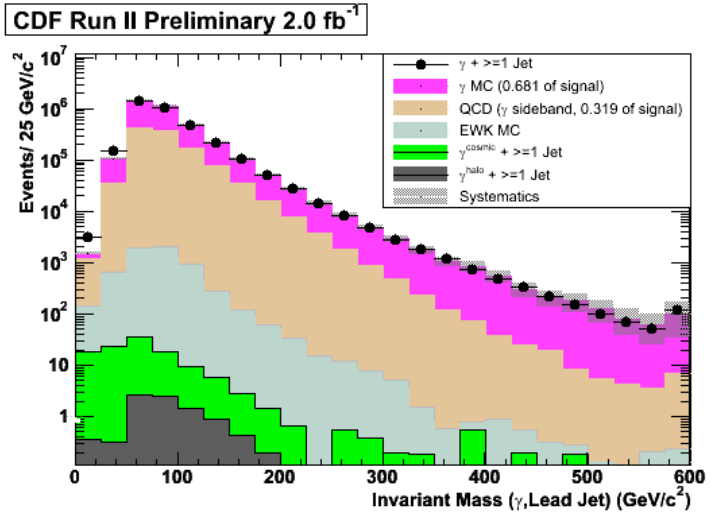
Systematics

- JES
- Fake photon fraction
- Uncertainty in the Cosmic and Beam Halo estimates
- Statistical
- Luminosity 6%
- EM uncertainty of 1%

Anomlaous jet +γ



Photon E_T is one of the strong indicators of new physics. An excess in photon E_T would indicate new heavy particle decaying to photons and jets.



Very good agreement between data and SM

To DO:

Finalize remaining systematics and improve them.

Include all available data.

Apply a MET cut (QCD veto) and scan all kinematic plots for bumps

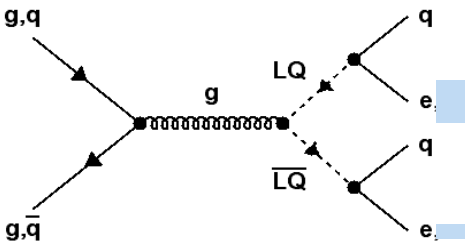
Search for first generation LQ

Update of the previously published analyses

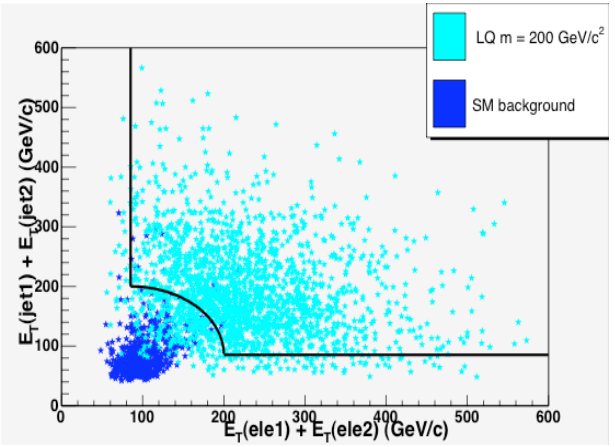
Simona Rolli (Tufts)
Gabriel Dunn (Tufts/FNAL)

Selection

- ✓ 2 electrons (CC,CF) E_T > 20 GeV
- ✓ 2 jets, E_T(j1) > 30 GeV, E_T(j2) > 15 GeV
- ✓ Z Veto (76 < $M_{\mu\mu}$ < 110) GeV
- ✓ **Electrons/Jets: $E_T^{j1(e1)} + E_T^{j2(e2)} > 85$ GeV**
- ✓ **$((E_T(j_1) + E_T(j_2))^2 + (E_T(e_1) + E_T(e_2))^2)^{1/2} > 200$ GeV**



SM background
Drell-Yan+2jets
Top (dilepton)
QCD/Fakes



Differences with previous analysis

Several things have changed since the previous analyses

•Ntuple format - we used eN ntuples previously but the package is not maintained anymore (plus we did the ntuple skimming)
    •we are using TopNtuple now

•MC Release - our previous analysis was based on gen5 MC
    •We have regenerated the signal samples with 6.1.4mc and recalculated our signal efficiencie
    •We are also using the Top group W+jets and ttbar samples generated with 6.1.4 (alpgen samples)

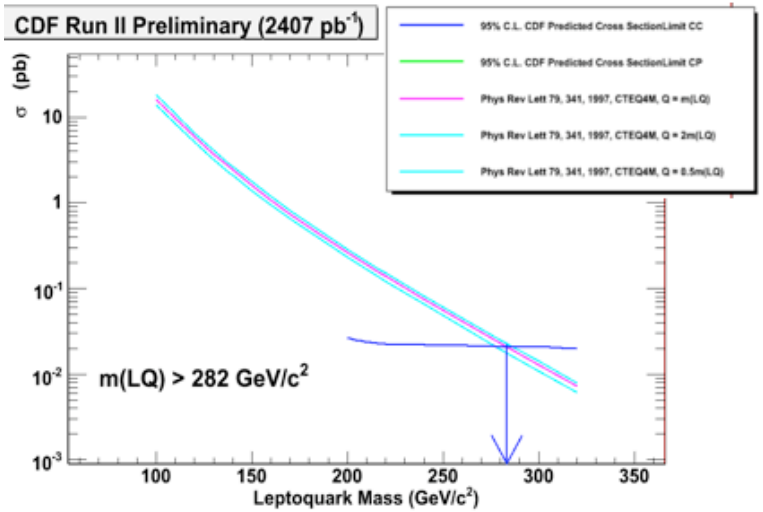
•These are the major changes, essentially in the infrastructure

Results

Preliminary limit with 2.4fb-1

- We used a rather large uncertainty on the background:
  - 50% uncertainty on the number of predicted background (consistent with the 200 pb^{-1} analysis)
  - We used bayes to calculate the limit

P8-P19



Plan to bless by the end of the year

Number of observed events: 11

$\sigma_{LIMIT} = N_{LIMIT}/(\mathcal{L} \times \varepsilon \times \beta\beta)$

$\beta = 1$

Expected background 8.97± 4.0

Limit improved of ~50 GeV

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Simona Rolli - LQ

Conclusions

The VEP group is small but active!

All the analyses are constantly monitored for updates and we plan to complete and bless them all by the end of 2010

We welcome more people! There are a few interesting topics that need analyzers! Come and talk to us!